the dominant dissociation pathway of the N_2 ground state. This is a predissociative process in which the dissociation products are ^4S + ^2D, in agreement with laboratory measurements.

Electron collisions with the X state of N_2 also produces the metastable $A^3\Sigma_u^+$ state. The A state has been observed in dayglow and in the aurora. The second figure presents a number of dissociation pathways of the A state. Unlike the X state, the dissociation of the A state favors a direct process in which the lower state is directly excited to a repulsive state. The dissociation products distribute among the ^4S, ^2D, and ^2P states.

Calculations of the electron-impact excitation cross sections of the X and A states to the predissociative or dissociative states show that the A state excitation cross sections are of the same magnitude or larger than the X state. Based on these results, the distribution of N atoms with 60% in the ^2D state is favored.

A factor that has not been considered so far in the modeling is the interaction of the A state of N_2 with the O atom to form NO. Since the A state is expected to be more reactive than the ground state, this will provide another source of NO and further lessens the discrepancy between modeling and measurement.

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Transient Meteor Activity

Peter Jenniskens

In 1997, Ames Research Center proved to be uppermost in studies of transient meteor activity. Meteor storms and lesser outbursts are spectacular natural phenomena that have eluded systematic study with modern techniques. During an outburst, meteor rates increase above the normal annual activity for a period that typically ranges from 1 to 24 hours. Little is known about why it sometimes "rains stars" at night. An answer to this question is key to the information that is particular to these events. For example, outbursts provide a unique window on how comets shed the large millimeter-to-centimeter-size dust grains that contain most of the mass lost by comets in the form of dust.

With the archiving center at Ames, a Global Meteor Scatter Network (Global-MS-Net) was made operational this year; it has stations in Finland, Hawaii, Austria, and Belgium, and two stations in Japan, operated by amateur astronomers. For the first time, meteor activity was monitored on a 24-hour and global basis (see the figure), but not yet in the Southern Hemisphere. Three outbursts were detected, all of known meteor streams: the Perseids, Leonids, and Ursids. On four occasions, the network provided upper limits to possible outburst activity reported by meteor observers and amateur astronomers.

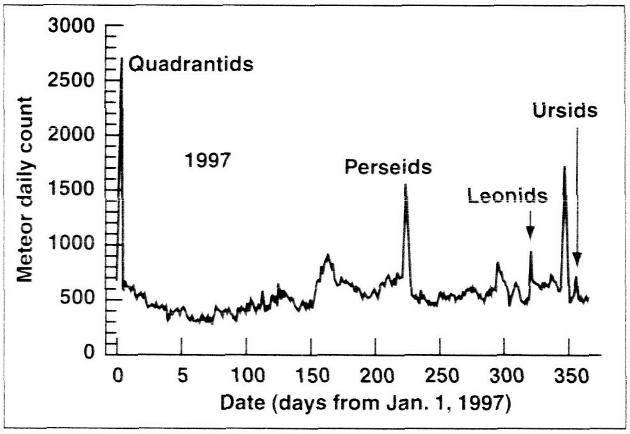

Fig. 1. Graph of the daily meteor count during the year of 1997 as measured by the Finnish Global-MS-Net station of Ilkka Yrjölä in Kuusankoski. The meteor streams discussed in the text are indicated.

Important progress was made toward determining how the Global-MS-Net detection of an outburst from the dust of a long-period comet can help predict its return in future years. The key is in the position of the major planets, because their gravitational perturbations affect the motion of the cometary dust trail that is responsible for the outbursts. Once it has been determined which planetary configurations direct that trail into Earth's path, it is possible to forecast a meteor outburst of the type caused by the dust trail of long-period comets. Typically, that happens only once or twice every 60 years. No new outburst associated with long-period comets was detected with certainty this year.

Work also progressed on studies of the outbursts caused by Jupiter- and Halley-type comets; all three outbursts this year were of those types. They were observed with a mobile photographic and video camera system, tracking the orbits of individual meteoroids, determining their grain morphologies, and measuring the particle-size distribution. Those results revealed that planetary perturbations play a role in the dispersion of cometary ejecta at a very early stage.

A surprising discovery came from similar observations of a well known annual stream, the Quadrantids. The results revealed structure in the distribution of orbits, implying ejecta less than 500 years ago. This stream turned out to have more in common with meteor outbursts than with annual shower activity. The stream does not originate from comet 96P/ Machholz 1, as was thought before. Rather, the source may be hiding as an asteroid-like object in a high-inclination orbit.

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Solar System Dynamics

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Progress has been made on several theoretical problems related to the dynamical structure of the solar system. Models of the early phases of the growth of solid planetary embryos on eccentric orbits were developed and used to calculate accretion rates and the accumulation of rotational angular momentum. It was found that eccentricities of the magnitude believed to be present during this period modify planetary growth rates and angular momentum accumulation only slightly, relative to the case of planets on circular orbits.

The torque exerted by a satellite on a particulate annulus centered at a mean-motion resonance was studied by using both analytic and numerical techniques. In the linear approximation, the net torque on the disk is the same as that exerted on fluid disks (which were studied previously by P. Goldreich, California Institute of Technology, Pasadena, California, and S. Tremaine, Princeton University, Princeton, New Jersey). The width of the annulus over which the bulk of the torque is exerted shrinks as time increases. The torque in a nondissipative disk is limited in time by nonlinear effects of the interaction close to resonance, which require a few thousand orbits to develop for typical solar system parameters. The same torque is obtained for disks of particles initially on circular orbits as for disks of particles on moderately eccentric orbits with periapses uniformly distributed in longitude. Results of these simulations are applicable to low-optical-depth planetary rings, such as Neptune's Adams Ring, and to planetesimals within the protoplanetary disks.

Systems of planets with orbits initially identical to subsets of the planets within our solar system were integrated for very long periods of time (billions to tens of billions of years) with the Sun's mass decreased relative to the masses of the planets. Systems based on the giant planets show an approximate power-law correlation between the time elapsed until a pair of planetary orbits cross and the solar-to-planetary mass ratio, provided that this ratio is less than 0.4 times its current value. However, deviations from this relationship at larger ratios suggest that this correlation cannot be extrapolated to accurately predict the lifetime of the current system. Detailed simulations of the evolution of planetary orbits through the Sun's postmain-sequence mass-loss epoch suggest that the orbits of those terrestrial